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DIGITAL ANTHROPOMETRIC VIDEO-IMAGING DEVICE (DAVID) OPERATIONAL MANUAL

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ABSTRACT

The digital anthropometric video-imaging device (DAVID) was developed as a computer-based technology capable of accurately and reproducibly completing anthropometric measurements during medical screening of aviation candidates. The DAVID technology is currently employed as the anthropometric screening tool for naval aviation candidates, however it is still undergoing modifications and revisions. This report is the first version of the operation manual and is intended as a tool for DAVID operators to use to complete anthropometric measurements. It provides step-by-step procedures for entering demographic data, acquiring images, completing measurements, transferring and storing files, and performing system calibration.

Acknowledgments

The authors wish to thank John Joseph of Isoperformance, Inc., for developing the initial Visual Basic program for the DAVID and the staff of SPAWAR System Center Charleston, Pensacola Office (especially Tan Dang) for their continuous, expert programming support. We would also like to thank Kathy Mayer for her expert editing of the manuscript.

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I. INTRODUCTION

A. DESCRIPTION

The digital anthropometric video-imaging device (DAVID) is a computer-based method developed to obtain anthropometric measurements (see Fig. 1). The DAVID was specifically designed to replace the existing manual method, the Integrated Anthropometric Device (IAD), (9) for screening aviation candidates in the Navy. The DAVID procedure involves acquiring images of a person in a standard anthropometric pose and then obtaining measurements via the image (see Fig. 2 for flowchart of the DAVID). Two electronic data files are generated. One provides information for automated entry into a database, and the other provides a one-page anthropometric report for the candidate's medical record. Reports contain essential demographic data, the images with overlaid measurements, and a numerical listing (in metric and English) of the measurement data. Figure 3 is a sample DAVID report.

The DAVID provides an automated method for obtaining anthropometric measurements and archiving data files that can be retrieved for review/evaluation. This capability enables a rigorous quality control program as well as retrospective review of individual files to assist in mishap investigations and pipeline decisions for student aviators. This technology has the potential for adding additional measurements, interfacing with other software programs (modeling, multivariate analysis, etc.), or being linked to a network, where one central site can complete measurements on files provided (via the Internet) from numerous remote sites. The DAVID methodology has been validated against both the standard anthropometer method used in anthropometric surveys (10,11) and the IAD (12).

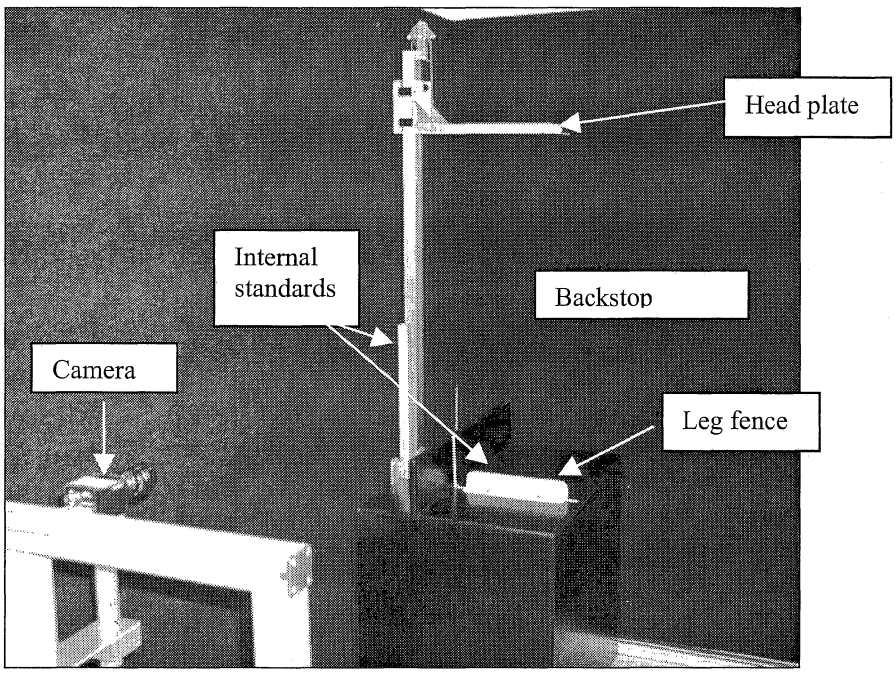


Figure 1. DAVID system

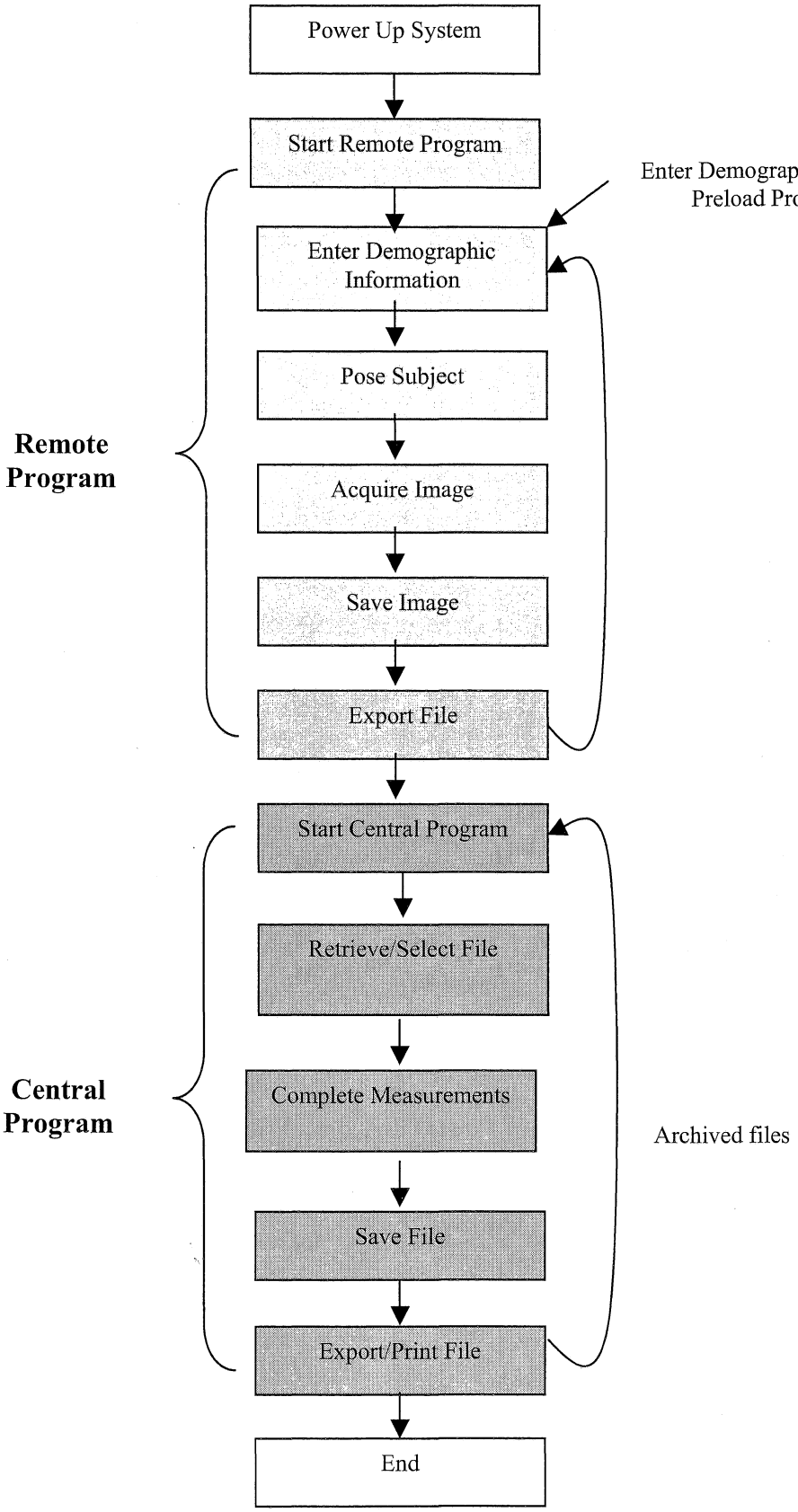


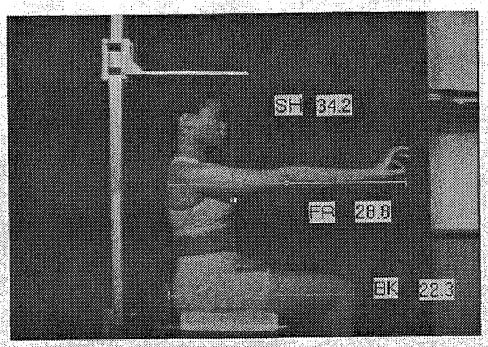
Figure 2. Flowchart of DAVID operations.

ANTHROPOMETRIC DATA

				Dimension Name	Inch	Cm
Entry Date	10/18/2001 9:12			Height	66	167.6
Subject Name	DOE, JANE A		FR	Functional Reach	28.8	73.2
SSN/ID	333-22-4444		BK	Knee Length	22.3	56.6
Rank	1		SH	Sitting Height	34.2	86.9
Service	Navy					
Sex	F					
Age	28			Neck	13	
Weight	141			Abdomen	0	
Category	Pilot			Hip (F)	38	
				Waist	28	
				Wrist (CG)		

BMI	
Navy	Marine
25	0

BF %



Comments

Technician **Signature of Physician**

Figure 3. Sample DAVID report.

B. ARCHITECTURE OF THE DAVID SYSTEM

The DAVID was initially designed to acquire images at remote sites and transmit them to a central location for processing, generating reports, storing files, and maintaining a database. This initial architecture was preferred because aviation candidates entered the program from various entry points such as the U.S. Naval Academy (USNA), Officer Candidate School, and directly from universities via Military Entrance and Processing Stations (MEPS). Remote sites located at major entry points (e.g., USNA, Naval Aerospace Medical Institute (NAMI), and larger MEPS) would enable early anthropometric screening and a reduction in the cost/time required to send people to Pensacola, Florida, for training and anthropometric evaluation. Since the beginning of DAVID development, the need for numerous remote sites has been reduced due to reorganization of the anthropometric screening process. Currently DAVID systems are located at NAMI, USNA, and the Marine Corps Development Command, Quantico, Virginia. The Naval Aviation Schools Command (NASC) is responsible for evaluating DAVID data (sent from the various locations), pipeline assignment, and electronic file storage of the DAVID files.

C. POWERING UP SYSTEM

1. Turn power on for computer, monitor, printer, camera, and subject light.
2. Start computer.

II. REMOTE PROGRAM OPERATIONS

A. ACTIVATING THE REMOTE PROGRAM

Activate the Remote Program by double clicking the Remote Program shortcut on the desktop.

B. INITIAL SCREEN

Many of the operational features of the Remote Program are shown in Fig. 4, which is the initial screen. The purpose of the Remote Program is to enter the subject's demographic data, acquire an image, save the file, and export the digital information to the Central Program. Images for calibration purposes are also acquired in the Remote Program.

C. DEMOGRAPHIC DATA ENTRY

Required demographic data are the subject's name, Social Security Number (SSN), age, weight, and height. The operator can enter the demographic data directly into the demographic section of the Remote Program, or the data can be preloaded into the **Remote Data Preload Program** (see Chapter II D). Fields in the demographic section are listed below:

1. Name: Last name, First name MI (e.g., Doe, John M)
2. SSN: (e.g., 123-45-6789)
3. Rank: (e.g., E3, E7, 01, 06, etc.)
4. Service: Select from drop-down menu choices:
   a. Navy
   b. Marine
   c. Coast Guard
   d. Air Force
   e. Army
   f. Foreign (specify country)
   g. Other (specify)
5. Sex: M or F
6. Age: In years
7. Weight: Pounds
8. Height: Inches
9. Category: Select from drop-down menu choices:
   a. Pilot
   b. Naval Flight Officer (AF Navigator)
   c. Student Pilot
   d. Student Naval Flight Officer (AF navigator)
   e. Medical/Flight Surgeon
   f. Medical Service Corps
   g. MIDN SNA (designation used at the Naval Academy)
   h. Aircrew
   i. Other (specify)
10. Priority: Select routine or urgent from drop-down menu.
11. Comments: The comments section is available if important notes need to be maintained with the file.
12. Neck, Abdomen, Waist, and Hip: Manual measurements are required if a percentage body fat calculation is required.

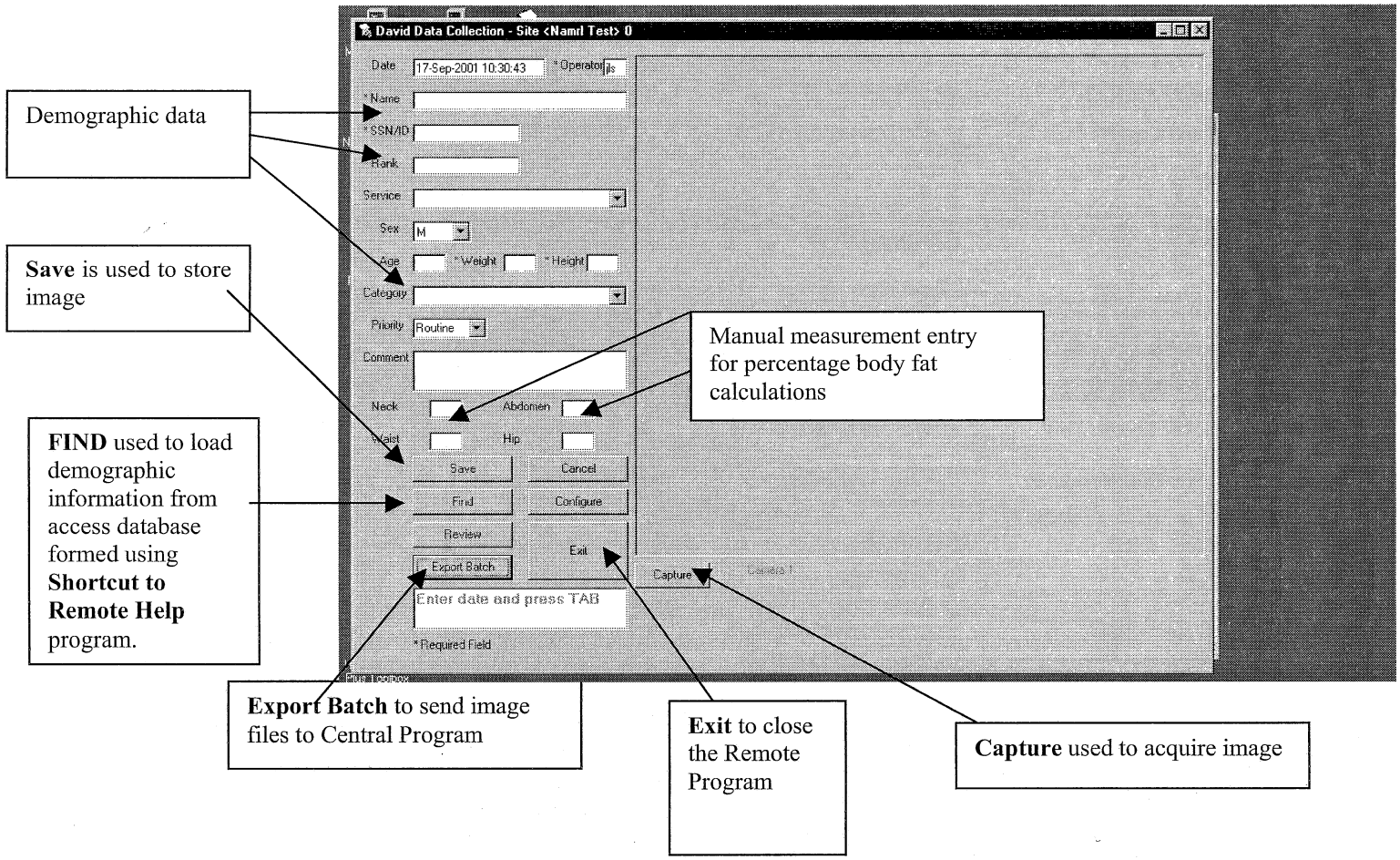


Figure 4. Remote Program initial screen.

D. REMOTE DATA PRELOAD PROGRAM

If the required demographic information is available before the measurements are to be made, it can be entered into the Preload Program and retrieved by inputting the subject's SSN into the Remote Program. The Preload Program enables quick retrieval of preloaded demographic data when it would be beneficial to reduce the process time due to a large number of subjects to be measured. To start the Remote Demographic Preload Program, choose **Shortcut to Remote Help** from the desktop. Figure 5 shows the screen for demographic data entry into the Data Preload Program.

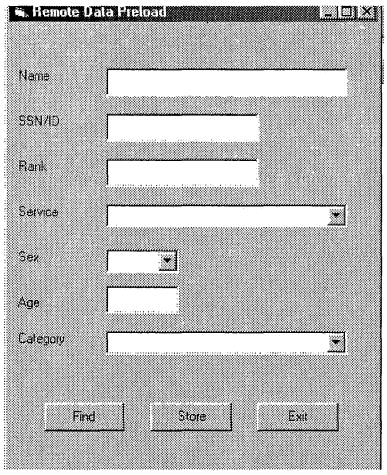


Figure 5. Demographic Data Preload entry screen.

Enter information into each of the required fields (name, SSN, weight, height, and operator ID) as well as any of the optional fields desired. When finished entering data for each subject, press **Store** and the data will be saved. (Note: The program will give a warning if duplicate SSNs are entered.) When completed, press **Exit** to return to the Windows screen. Not all of the preloaded subject data must be entered in the same session; each additional session will append data to the existing file. Data can also be imported into the program from another database.

To retrieve a subject's data, enter their SSN in the initial screen of the Remote Program and press the **Find** button (see Fig. 4). The appropriate information will be entered automatically into the demographic fields. The SSN must be typed exactly as it was initially entered in the Preload Program for a proper match (e.g., if hyphens were used when the SSN was entered, then hyphens must be used to retrieve the data).

E. ACQUIRING IMAGES

Before acquiring an image, situate the person in the appropriate anthropometric pose. The pose is based on the accepted standard pose used for anthropometric surveys employing manual measurements (1-8,13). The subject should be seated on the table as far back against the backstop as possible with their right thigh against the leg fence, the piece of metal located near the edge of the table facing the camera (see Fig. 1 for locations of the apparatus discussed in this chapter). See the Appendix for frequently occurring subject posing errors. Instruct the subject to sit up straight. Place their head in the Frankfort plane[1] and lower the head plate so it touches the top of their head. Have the subject extend their right arm straight out in front of them, parallel to the floor, with their right index finger touching the tip of their extended thumb. Instruct the subject to raise their right knee such that their right leg is flexed at a 90-deg angle and their thigh is parallel to the floor. Figure 6 shows a properly posed subject. To acquire the image, first place the cursor on the camera image and click the left mouse button (the image will then become a real-time picture and fill the screen, shown in Fig. 6). Verify that the subject is positioned properly and, if needed, make any final positional adjustments. Click the left mouse button again and the image is acquired (the image will then return to its original size). If after completing this process, it is necessary to reacquire the image, left-mouse

[1] Defined as the standard horizontal plane or orientation of the head. The plane is established by a line passing through the right tragion (approximate ear hole) and the lowest point of the right orbit (eye socket).

click on the image. A warning window will ask if you want to discard the original image, click **YES** and repeat the acquisition process.

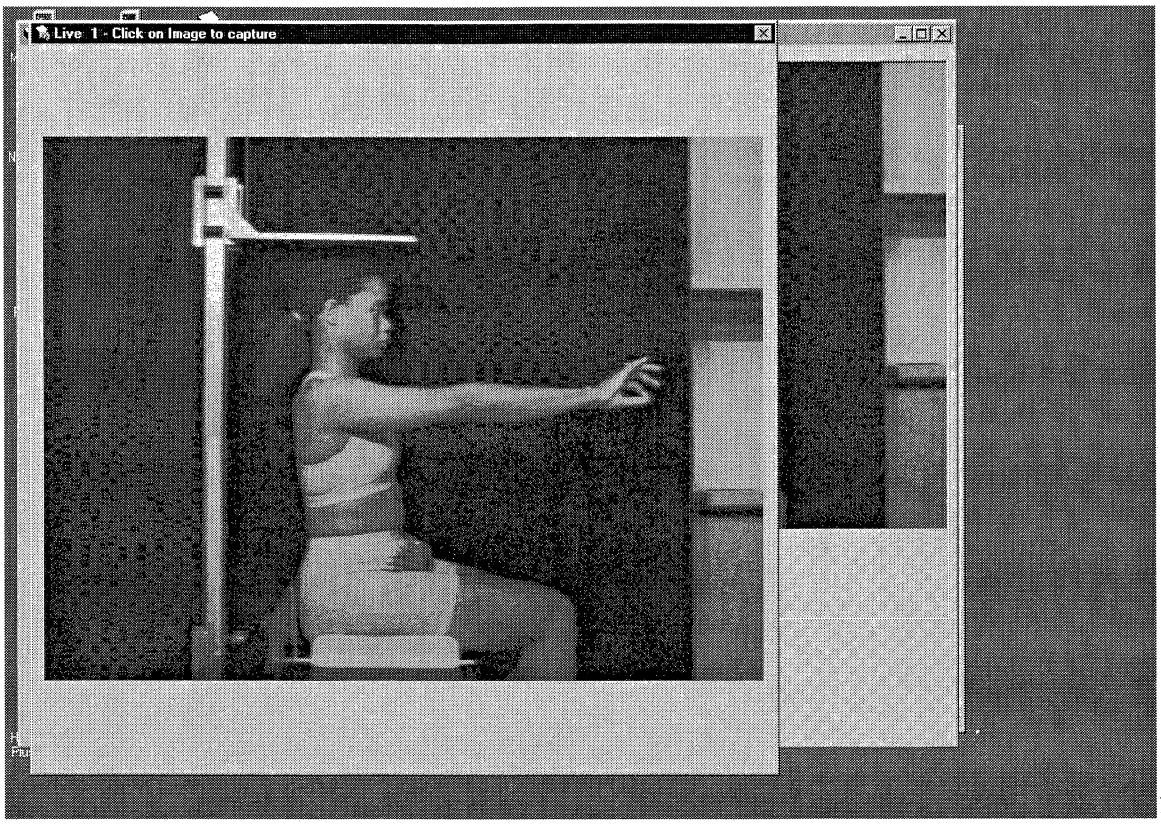


Figure 6. Image-acquisition screen.

Care must be taken to ensure that the subject is properly posed. The operator must ensure the subject remains in the Frankfort plane. Occasionally, when the subject is concerned their sitting height may be too short, they will try to increase their sitting height by looking up and not maintain the Frankfort plane. Additionally, if they are allowed to slouch and not sit up straight, the sitting-height measurement will be incorrect. Some people are reluctant to sit up straight if they do not have a adequate back support. If a subject appears to be slouching after the initial request to sit up straight, repeat the request. If they still appear to be slouching, assume that is their normal posture and acquire the image. Another potential problem can occur if the subject does not fully extend their thumb. If the thumb is fully extended, there should be a straight line from their shoulder to the tip of the thumb. Additionally, the subject must hold their thigh parallel with the floor. It is difficult for the subject to know when their thigh is parallel to the floor, so the operator must look at the real-time image and instruct them to raise or lower their knee until the correct position is obtained.

F. ENTERING PERCENTAGE BODY FAT DATA

The DAVID software can automatically calculate percentage body fat using Navy (male and female) and Marine (males only) tables. Appropriate circumference data must be entered manually in the demographic section for this function to work (see Fig. 4).

For male calculations (Navy and Marine), standing height, neck circumference, and abdomen circumference measurements must be entered. Calculations for Navy females require standing height, neck circumference, and natural waist circumference entries. Marine female percentage body fat cannot be automatically calculated in this version due to the complexity and exceptions in the formula.

G. SAVING FILES

Once the image has been acquired, it is stored by clicking the **Save** button (see Fig. 4). If the acquired image is not saved before proceeding to the next subject, a warning window will alert the operator that the file must be saved or the image will be lost.

H. EXPORTING/TRANSFERRING FILES

A file (or group of files, if more than one subject has been saved since the last export) must be transferred electronically from the Remote Program to a Central Program. The process is initiated with the **Export** button (see Fig. 4). The file name, generated by the program, is based on the date and time of day. The operator can press the export button after each subject has been saved or wait until numerous subjects have been completed. Although many subject images can be acquired before exporting, frequent **Export** operations will reduce potential loss of data in the event of a system error. Once a file is exported, it is no longer available in the Remote Program.

III. CENTRAL PROGRAM OPERATIONS

A. ACTIVATING CENTRAL PROGRAM

Activate the Central Program by clicking the desktop shortcut.

B. INITIAL SCREEN

Figure 7 shows the initial screen of the Central Program. The Central Program is used to complete measurements on the image transferred from a Remote Program. When the **Export** button is activated in the Remote Program, the files containing the image and demographic data are transferred electronically to the Central Program. Measurements are systematically made on the image, the report file is saved, a report is generated, and measurement/demographic data are saved in a database. The Central Program also includes a routine for archiving completed files to a CD.

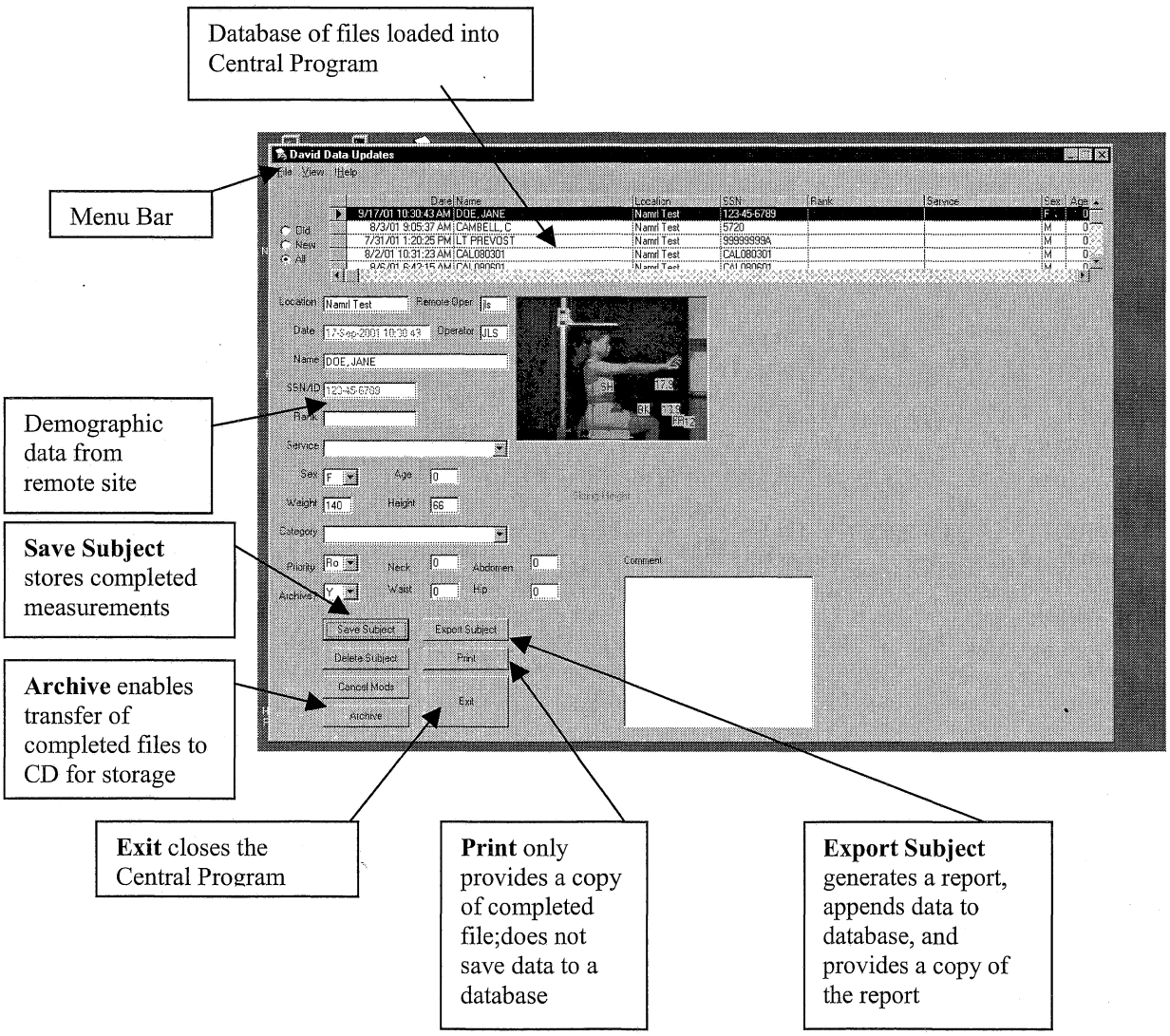


Figure 7. Central Program main screen

C. MENU BAR CHOICES

The Menu Bar has three choices, **File**, **View**, and **Help**, each of which has drop-down functions.

1. **File** drop-down functions:

   a. **Check Data from Remote.** To load new files sent from remote site(s).
   b. **Retrieve Subject from Archive.** To load a completed file that has been removed from the Central Program and archived on a CD (discussed in Chapter V) or the Archive folder in the central directory.
   c. **Load Calibration Set.** To load a calibration set different than the default (discussed in Chapter IV).
   d. **Save Calibration Set.** To save the active file as calibration data. These data will be the default calibration data until either a new calibration set is loaded or a new calibration set is saved (calibration procedures are discussed in Chapter IV).
   e. **Exit.** To exit the Central Program.

2. **View** drop-down functions:

   a. **View Change Log.** To access the change log database that maintains a record of changes made to DAVID files (see Chapter VI for a description of database tables).
   b. **Image Names.** Not relevant in current version.
   c. **Database Tables.** To view the tables (measurement information, calibration information, etc.) in the Central Program (see Chapter VI for a description of base tables).

3. **Help** contains an indexed copy of this operating manual.

D. RETRIEVING FILES FROM A REMOTE PROGRAM

The window at the top of the main Central Program initial screen shows a listing of the files (subjects) currently loaded into the Central Program (see Fig. 7). Both completed files and files without completed measurements are included in the list. New files exported from the Remote Program are loaded automatically when the Central Program is initially started; however to load subsequent files the operator must use **Check Data from Remote** under **Files** in the **Menu** bar. Use the scroll bar to view files not visible in the window.

E. SELECTING A FILE

The buttons to the left of the file database allow viewing of **Old**, **New**, or **All**. In either **New** or **All** modes, files without completed measurements are shown. Selecting **Old** will show only files with completed measurements. The database is sorted by SSN. Once the appropriate file is located, the column to the left of the date column should be selected by a left-mouse click. This will activate the file, load the image onto the initial screen, and make it available for processing/review.

F. COMPLETING MEASUREMENTS

Making the measurements can be divided into three steps:

1. First, select the image by placing the cursor on it and clicking the left mouse button. This will fill the screen with the image. It will also overlay the red measurement bars to prompt the operator for measurements that are to be completed.

2. Second, make the measurement by setting the measurement bars to define the limits of each measurement. Measurements are based on the same standard landmarks used in anthropometric surveys (1-8,13). Each is described below. The definitions are modified from Gordon et al. (6). Figure 8 shows the proper location of the measurement lines when the measurement is completed. The Appendix includes frequently occurring measurement errors.

a. **Buttock-knee length.** The horizontal distance between the backstop and the anterior point of the right knee is measured. The subject sits erect, thighs parallel (held at right angles from the backstop), and the knees flexed 90 deg with the feet in line with the thighs. The image is acquired while the subject lifts their right knee up until the thigh is parallel with the floor. An alternative method would be to use a height-adjustable footrest that could be lowered or raised to position the thigh parallel with the floor.

b. **Sitting height.** The vertical distance between a sitting surface and the top of the head is measured. The subject sits erect with the head in the Frankfort Plane. The head plate is lowered to the top of the subject's head. The measurement is made from the top of the sitting surface to the bottom front edge of the head plate.

c. **Thumb-tip reach.** The horizontal distance from the scapula to the tip of the right thumb is measured. The right arm and hand, palm down, are stretched forward horizontally. The thumb continues the horizontal line of the arm, and the index finger curves around to touch the pad at the end of the thumb. To ensure the right scapula can be seen in the image, set the subject up with his/her back slightly angled with the right shoulder behind the left shoulder (if the subject is set up with the left shoulder behind the right one it is difficult to identify the back edge of the right scapula). This measurement is a modification from the normal pose with the subject in a standing position.

Generally, to position the measurement lines, the "red" bar is first moved to the appropriate location of the measurement, and the "T" at the end of the bar is adjusted to the appropriate landmark. To move a measurement bar, place the curser over the box in the middle of the bar and hold the left mouse button down while dragging the bar. Depending on which measurement is being made, one end of the bar may be set to a specific horizontal or vertical plane while the other end is be adjusted to the appropriate landmark. For example, sitting height is measured by adjusting the top "T" of the bar to the bottom front edge of the head plate. The lower end of the sitting-height bar is preset on the seated surface, corresponding to a line directly underneath the front edge of the head plate. The preset location can be changed by disengaging the Lock Reference feature (see discussion on **LOCK REFERENCE** below). When the bar is in the desired location, release the left mouse button. To adjust the length of the line, place the curser over the appropriate "T" at the end of the bar and depress the left mouse button. Move the "T" to the desired location and release the left mouse button. Successive clicking of the right mouse button enlarges the image (with the location of the cursor at the center of the enlarged area). By zooming in, the operator can more accurately place the "T" at the proper location. After three right-mouse-button clicks, the image returns to the original zoom level (there is no other way to return to the original zoom level other than to cycle through the various levels). Once the bar is moved, the color changes from red to blue to indicate that a measurement has been attempted.

3. Once all of the measurements are completed, the **Return to Main Screen** button exits the measurement routine. If the operator attempts to exit the measurement routine without moving all of the measurement bars (and at least one of the bars is still red) the program will display a warning that not all of the measurements have been completed.

Care should be taken not to make changes inadvertently to the entries in the Dimension database table (at the top of the screen) or the Dimension Defaults (at the lower left of the screen) as they are used to change the default calibration and measurement settings. Incorrect changes to either of these areas could result in inaccurate measurements and may require the DAVID software to be reloaded to correct the problem.

The **Show Calibration** option is used only during calibration procedures. That option is discussed under calibration procedures in Chapter IV.

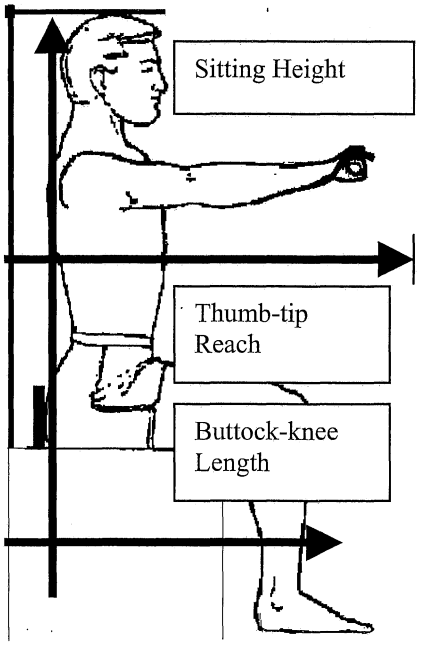


Figure 8. Diagram of measurements

Figure 9 shows how the image should appear with completed measurements. The vertical measurement is sitting height (SH), and the horizontal measurements are thumb-tip reach (FR) and buttock-knee length (BK).

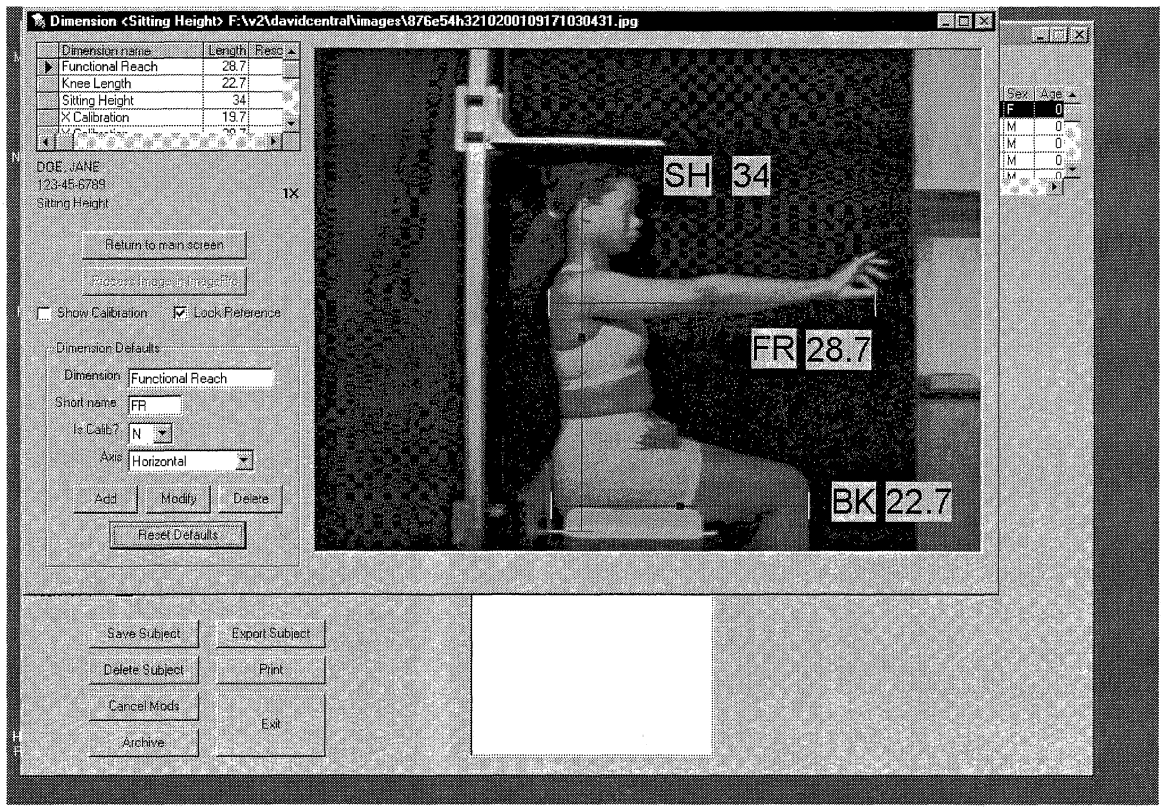


Figure 9. Measurement screen in Central Program

G. ENABLING/DISABLING LOCK REFERENCE FEATURE

If the box labeled **LOCK REFERENCE** is checked (see Fig. 9), the left side of the buttock-knee length bar and the bottom of the sitting-height bar cannot be adjusted for distance. Both lines can be repositioned along the plane of calibration in the "locked reference" plane; however they cannot be repositioned to change the dimension length. For example, although the sitting-height measurement bar can be moved from right to left, the bottom end cannot be moved up or down because it would place the measurement either in front of, or behind the calibration plane. The opposite end of each bar is adjusted to make the measurement. When the **LOCK REFERENCE** box is not checked, this feature is disabled and both ends of the measurement bars must be adjusted.

H. SAVING/EXPORTING A COMPLETED FILE

When measurements are completed, the file must be **Saved** to preserve them, otherwise they will be lost. To reduce the chance of losing completed measurements, the operator is warned by the program that unsaved dimensions exist if another file is selected without saving the previous one. After saving the file it can be **Exported.** This will append the data to an anthropometric database (the default is a Microsoft Access database, DavidOutputData.mdb, in the central folder), generate a report file (Microsoft Excel format), and print a copy of the report. Every time a file is exported, the data are automatically appended to the database.

I. PRINTING A FILE

The **Print** button is used if only a printout is needed. We strongly recommend that the file be **Saved** before printing it. The file is **NOT** appended to the database during this printing function.

J. ARCHIVING FILES TO A CD

Archiving files to a CD provides permanent storage for completed DAVID files. Only files with all of the measurements completed and saved can be archived. The last field of the file database (at the top of the main central screen) contains either **Y** or **N** to indicate if a file is to be archived with the next set. If a file is not to be archived, the operator must ensure an **N** is in that field. To change the archive status of a file, select **VIEW DATABASE TABLES** under **View** from the menu bar. The **Subjects** table is at the top (see Fig. 10).

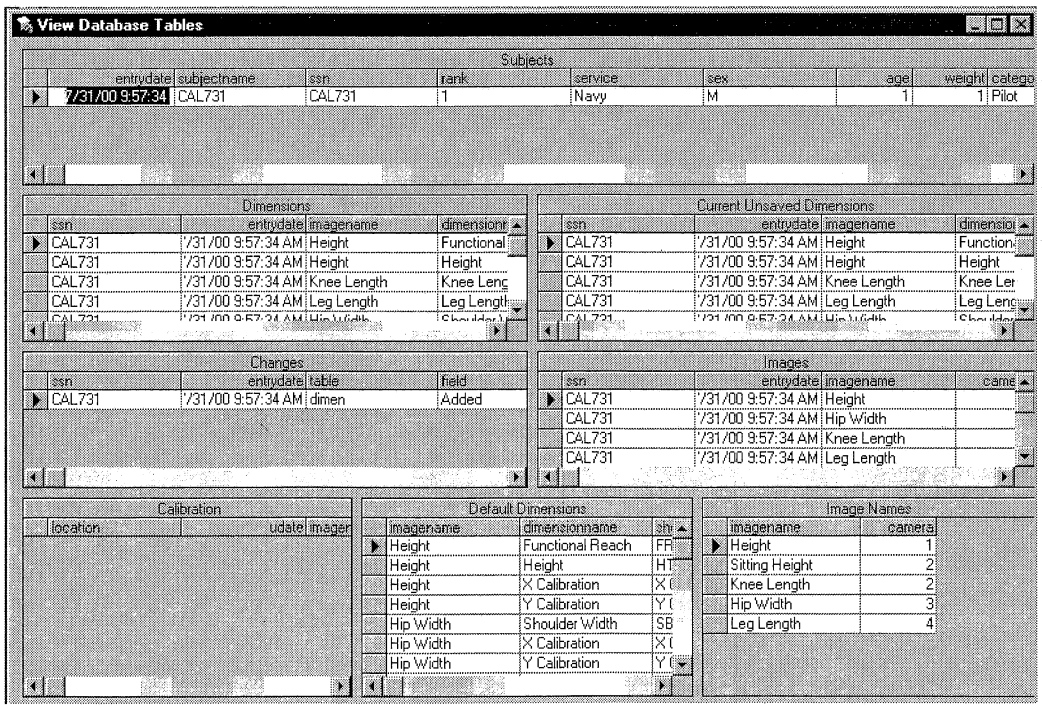


Figure 10. Database table screen of Central Program

Choose the subject(s) that need their archive field changed and make the appropriate change to **Y** or **N**. Once the field is changed using the **VIEW DATABASE TABLES** routine, that change will be reflected in the window at the top of the main Central Program screen. After all subjects to be archived have a **Y** in the archive field of the database, press the **Archive** button. All of the files with a **Y** will be listed for the operator to review and confirm continuation of the process (Fig. 11). When **OK** is selected, the listed files will be transferred from the central database to the Archive folder in the central directory. The archive routine creates a compressed file that contains the individual files and other information (calibration, demographic, remote site location, etc.) required to retrieve/modify the data. The file name of the compressed file is based on the year, month, day, minute, and second the file was generated. From there, the operator can electronically transfer the file to the central repository site (see **Transmitting/Receiving Files to Another Location** below), and/or retain it in the archive directory where it can be transferred to a CD for permanent storage (follow CD software instructions for drag and drop procedures). Once archived, the files are removed from the Central Program and are not available until retrieved (see **LOADING FILES INTO CENTRAL PROGRAM** in Chapter V).

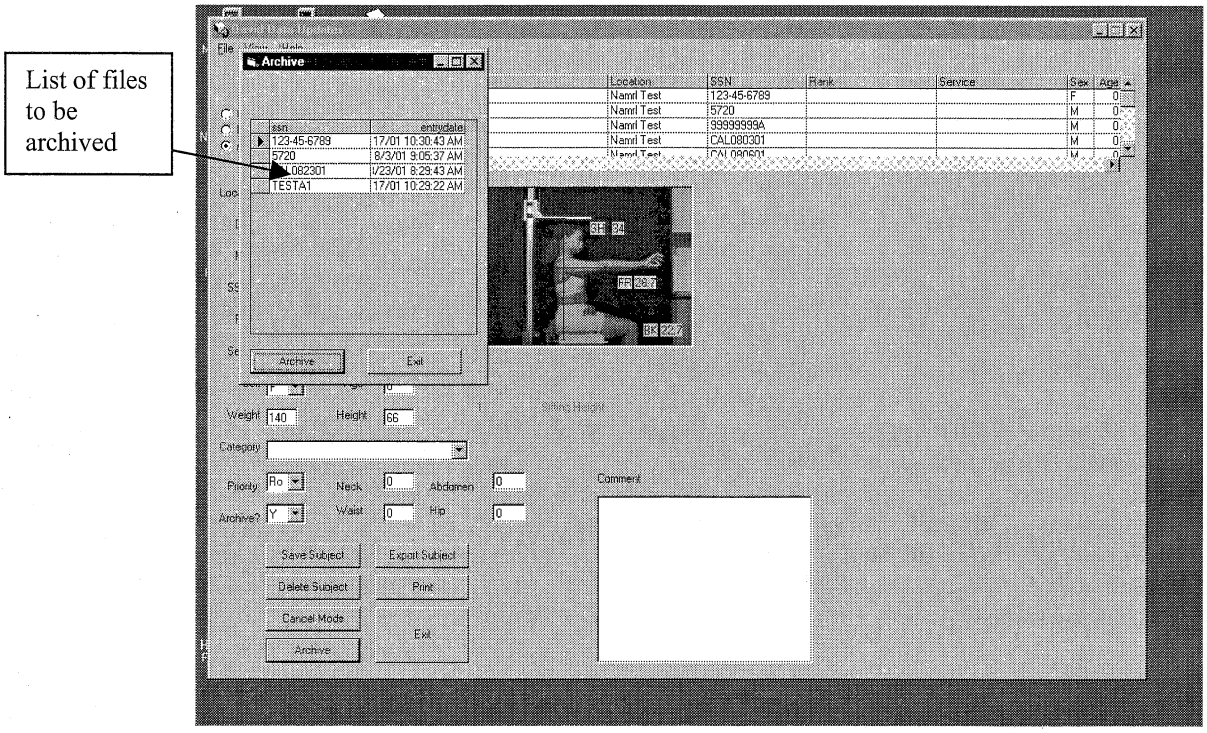


Figure 11. Archiving files screen of Central Program

K. TRANSMITTING/RECEIVING FILES TO ANOTHER LOCATION

Both remote site files and completed central site files can be transmitted from one location to another via the Internet. The exact procedure to prepare files for transmission will depend on the specific location.

To receive files sent from another location, the operator will either load the files into the Central Program for review/modification or move them into the archive directory for the next CD backup. As with transmitting the files, each location will have specific instructions for these procedures.

IV. CALIBRATION PROCEDURES

A. GENERAL CALIBRATION INFORMATION

Calibration is required to define the number of pixels/inch for linear measurements in both the vertical and horizontal planes. To ensure proper functioning of the system, routine calibrations should occur daily or whenever image-acquisition hardware (i.e., camera, lens camera support, or apparatus for the subject to sit on) has been changed, adjusted, or moved. This procedure involves placing a calibration tool with known dimensions in the plane in which the measurements will be made and setting the computer program to those dimensions.

The first step in the calibration procedure is to acquire the image with the calibration tool in the correct location. The Remote Program calibration file is then transferred to the Central Program where the calibration measurements are completed. The file is saved in the Central Program as a calibration file and used as the default calibration data until a new calibration set is determined.

B. REMOTE PROGRAM PROCEDURES

In the Remote Program, an image of the calibration tool is acquired (after it has been placed in the proper measurement plane). The following describes the process to generate a suitable calibration image.

1. **Naming calibration files.** The name of the calibration file is important to distinguish it from routine measurement files. The name must also reflect the date the calibration image was acquired so the operator can identify the correct calibration set (if it must be manually retrieved at a later date). The following is the naming convention to be used for both the **Subject Name** and **SSN** in the demographic data section: the first three letters must be **"CAL"** followed by the date in Month-Day-Year format (mmddyy), e.g., "CAL010101." Anything can be entered in the other required fields.

2. **Acquiring the calibration image.** The calibration tool must be placed in the plane in which the anthropometric measurements will be made (see Fig. 12). If a calibration object is used, other than the original one, the appropriate dimensions must be placed in the calibration database in the Central Program (see **Changing Calibration Database Defaults** under that section). The calibration tool must be positioned on the sitting surface of the table with the side facing the camera butted up against the horizontal leg fence used to align the subject's right leg. Lower the head plate so that it rests on top of the calibration tool. The horizontal arms must be aligned in the plane of the horizontal leg fence (see Fig. 12).

3. **Saving and Exporting a Calibration File.** The procedure for saving and exporting calibration files is the same as for normal measurement files (see Chapter II). The name of the file designates it as a calibration file.

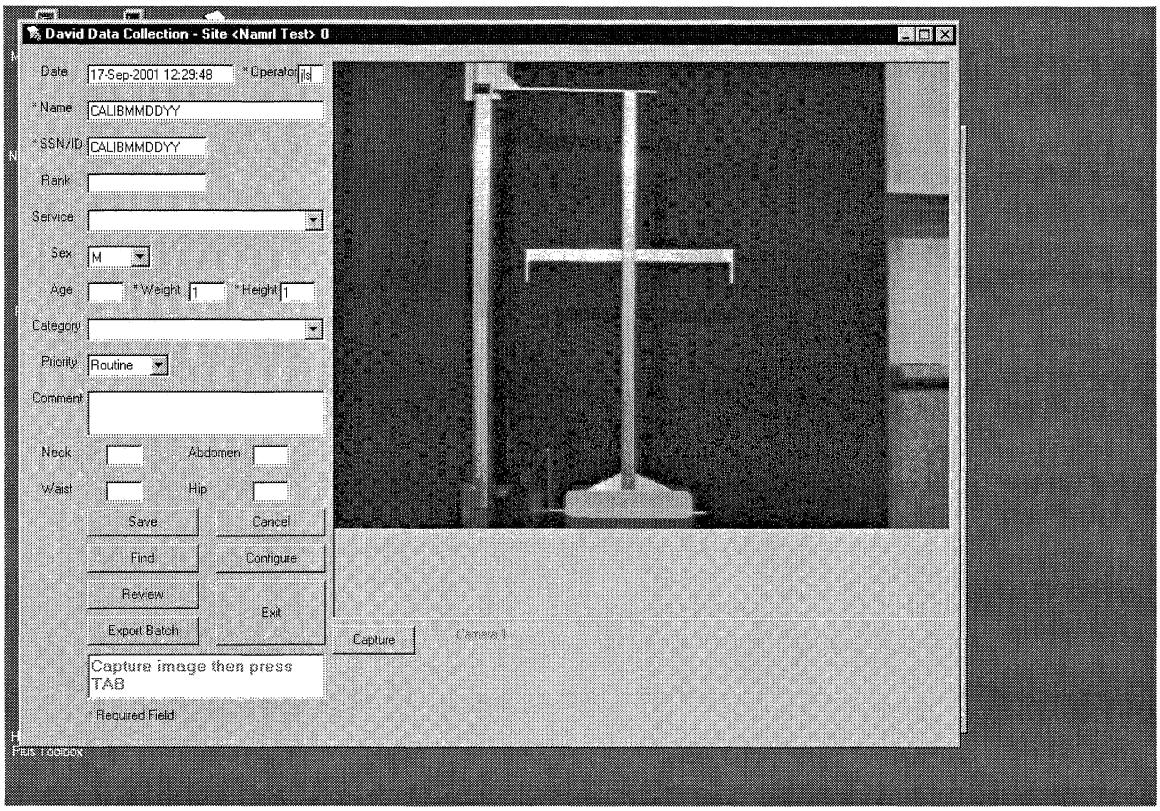


Figure 12. Calibration screen in Remote Program

C. CENTRAL PROGRAM CALIBRATION PROCEDURE

Processing calibration files is different from the procedures for normal measurement files. Attention to accurate measurements is imperative because these results will influence every measurement until a new calibration is made. Saving and storing calibration files also requires different procedures than routine measurement files.

1. **Retrieving Calibration Files.** The procedure for retrieving calibration files from the Remote Program is the same as for normal measurement files. They appear in the database list at the top of the Central Program screen. Calibration files can be identified in the database because both the file name and the **SSN** begin with "**CAL**."

2. **Completing Calibration Measurements.** One of the major differences in processing calibration files is that green calibration lines are used in the measurements instead of the normal blue anthropometric lines. To see the green lines, the box labeled **Show Calibration** must be checked (see Fig. 13). The operator should ensure that the appropriate calibration lengths for the calibration tool appear in the upper left window of the screen ("x" and "y" calibration lengths). To verify that the correct dimension is used, measure (in inches) the height and width of the calibration tool and compare them with those values shown. If they are not correct, follow the procedures listed under **Changing Dimensions of Calibration Tool** below.

   To complete calibration for the "y" line, measure the distance from the bottom front edge of the head plate to the bottom of the right leg alignment piece (to move the bottom of the sitting height and left side of the buttock-knee length bars, the **Lock Reference** box must **not** be checked). The "x" calibration line is set to the distance between the outside edges of the calibration tool horizontal arms. Figure 13 shows the correct placement of the calibration lines.

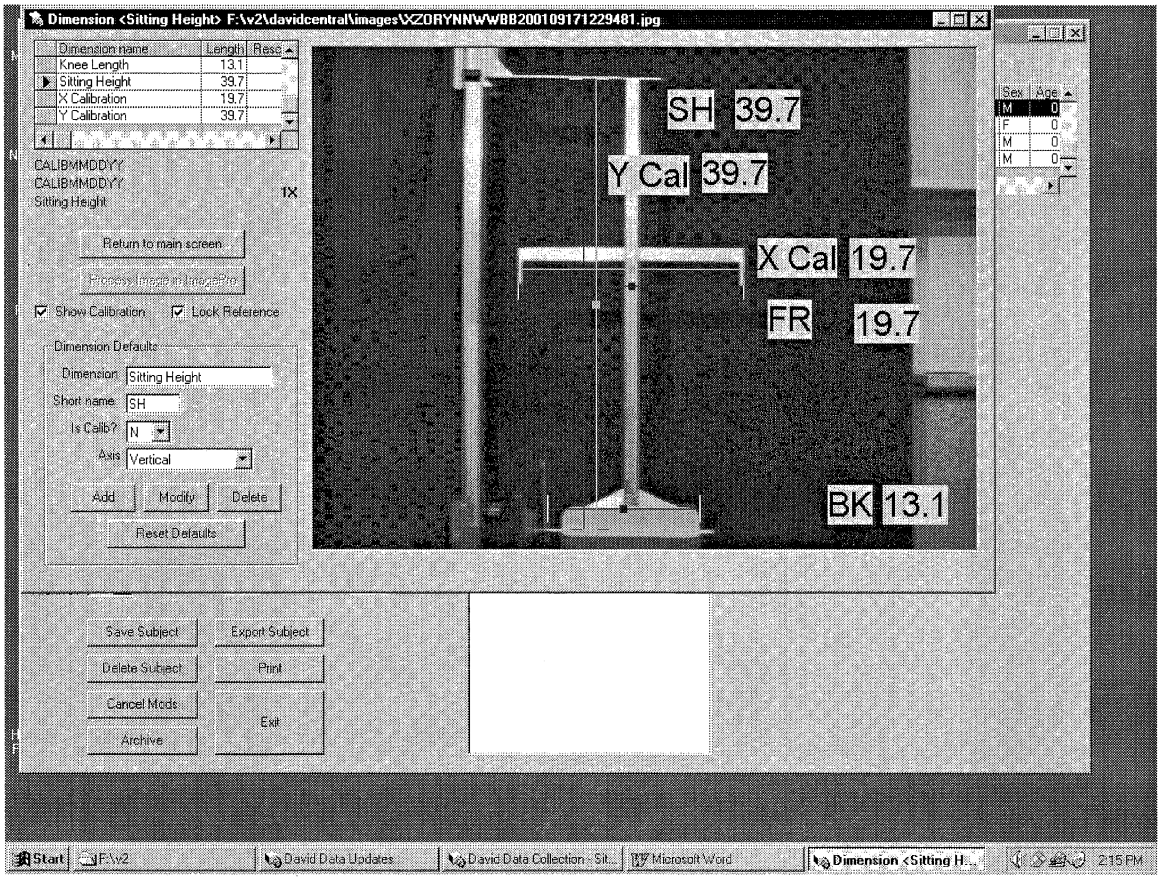


Figure 13. Calibration in Central Program

3. **Saving Calibration Files.** Once calibration measurements are completed, save and store the file by selecting **Save Calibration Set** under **FILE** in the menu bar. Because the data are not of a subject, the file should not be exported to the database.

4. **Printing Calibration Files.** Calibration measurements (green lines) will not appear when the file is printed. To obtain a hard copy of the calibration data, use the calibration tool as the "subject" and complete sitting height and thumb-tip measurements using the calibration tool as the subject. The buttock-knee length measurement can be made with the right edge of the internal standard on the sitting surface (see paragraph 8 of this chapter for a description the internal standards). A printout of the file will then show the calibration data and provide documentation of the calibration.

5. **Changing Calibration Database Defaults.** Calibration tables contain the dimensions of the calibration tool provided with the system. Changes to these dimensions will influence all of the measurements from the time the changes are made. The following examples describe when the default values should be changed:

   a. **Changing dimensions of calibration tool.** The current calibration values can be found in the upper left table of the screen used to complete the measurements (see Fig. 13). If the value is incorrect for either the **X Calibration** or the **Y Calibration,** the operator can change the appropriate value. To verify the appropriate value, manually measure the calibration tool and compare the measured value with the actual value. The **Modify** button in the Dimension **Defaults** box in the lower left of the screen must be selected and pressed for the software to incorporate the changes (see Fig. 13). To retain the new calibration dimensions as the default setting, push the **Reset Defaults** button. Once this occurs, all calibration measurements will reflect that change until a new value is stored.

b. **Adding a new measurement requiring new calibration dimensions.** If a new measurement is added and/or a different image is required, changes must be made to the program code before any new calibrations can be added.

6. **Loading a Different Calibration Data Set (replaces the current default calibration set).** This function is **NOT** usually required. For example, if a new calibration has been completed since a file selected for review was initially processed, the appropriate calibration data will be retained with the file. The operator will not need to manually load the calibration set that was current when the initial image was acquired. The same is true if archived files are retrieved for review/modification. The archive process attaches the calibration data with the files, so manually loading the appropriate calibration set is not required. Incorporating a different calibration data set than the default might be necessary if the operator wanted to compare current measurements with a previous calibration set or perform some other diagnostic procedure. Once a previous calibration data set has been loaded, it is only used for the current file; the Central Program reverts to the most recent calibration set for remaining files. To load a previous calibration data set, the operator must use the **Load Calibration Set** option under **File** in the main menu. Once the database appears, the operator must choose the calibration set desired. Once chosen, that data will be used with the current subject file.

7. **Internal Calibration.** The DAVID includes both horizontal and vertical internal calibration capability for verification of calibration. Because the internal calibration hardware is integral to the DAVID set (see Fig. 1), verification of accurate calibration can be accomplished anytime the file is reviewed. The calibration tool must be used to calibrate the DAVID system; internal calibration can only be used to check the calibration.

   a. **Vertical internal calibrator.** The right leg fence is 12 in long; it can be used to check horizontal calibration by using either the buttock-knee or thumb-tip measurement bar. One end of the bar should be aligned with the left edge of the leg fence, and the other end should be adjusted to the edge at the other end of the fence. If calibration is correct, the measurement should be 12.0 ± 0.1 in.

   b. **Horizontal internal calibrator.** There is an 18-in high bar at the back of the table in the same plane as the subject leg fence. The bar can be used to verify the vertical calibration using the sitting-height bar. The measurement should be 18.0 ± 0.1 in.

V. RETRIEVING/MODIFYING COMPLETED FILES STORED ON CDs

A. GENERAL FILE MANAGEMENT INFORMATION

The DAVID program enables retrieval of files for review or measurement correction. Part of the process requires maintaining the appropriate calibration factors with each file. This ensures that if a measurement must be corrected, it is accomplished with the same calibration factors originally used. Once archived to the archive directory or a CD, a file can be retrieved for review/modification. This chapter addresses the procedures for archiving files and retrieving them for review.

B. LOADING DATA FILES INTO CENTRAL PROGRAM

1. Place the appropriate CD in the reader (if the file has been transferred to a CD) or open the archive folder in the central folder.
2. Select **Retrieve Subject from Archive** from the **File** drop-down menu.
3. Select the appropriate file (stored by SSN).
4. Select **LOAD.** The file will be copied to the Central Program and will appear in the database (sorted by SSN) at the top of the Central Program main screen (see Fig. 7).

C. CORRECTING MEASUREMENTS

If the stored measurements appear incorrect, the operator can correct the measurements and save them (as described for routine measurements).

D. FILE NOT CHANGED

If no change was made to the file, it can be deleted from the Central Program database (when the file to be deleted is active, press the **Delete** button). The original copy is available if needed later.

E. ARCHIVING MODIFIED FILES TO NEW CD

The modified file will be stored during the next **Archive** process. To archive files to a CD, follow the procedure see Chapter III J. A system should be established locally to track the location of files archived to CDs.

VI. DATABASE TABLES

A. GENERAL DATABASE TABLE INFORMATION

All of the database tables are accessible in the Central Program by selecting **Database Tables** under the **View** drop-down menu. They can be viewed and modified either directly from the Central Program or via Microsoft Access (file name *central.mdb* in the central folder). The fields for each of the databases are briefly described below (Fig. 10 shows the database tables in the Central Program). **CARE MUST BE TAKEN** when making any changes to these tables as they can significantly affect the program functions and accuracy of the measurements. Before attempting any modifications, the original file should be copied as a backup in case the changes are unsuccessful. Some of the entries such as CAMERA are not relevant to the current version of the DAVID software. Previous versions included up to four cameras. The current DAVID architecture only requires one camera, so the camera number is not important.

B. SUBJECTS DATABASE (subject:table in central.mdb)

Database containing information about subjects:

1. ENTRYDATE:
2. SUBJECTNAME
3. SSN:
4. RANK:
5. SERVICE:
6. SEX:
7. AGE:
8. WEIGHT:
9. CATEGORY:

} Entries entered by operator in demographic data field of Remote Program

10. LOCATION: Default name of remote site
11. PRIORITY: Entry typed in by operator in demographic data field of Remote Program to indicate if the file is to be processed as routine or a urgent
12. COMMENT: Available for notes or results entered by the operator
13. UPDATED: Last date file was changed
14. ARCHIVE: "Y" or "N" to include file in next archive set

C. DIMENSIONS DATABASE (dimen:table in central.mdb)

Database containing the name, initial location, and orientation for each measurement:

1. SSN: Entry typed in by operator in demographic data field of Remote Program
2. ENTRYDATE: Entry typed in by operator in demographic data field of Remote Program
3. DIMENSIONNAME: Name of dimension in Microsoft Visual Basic program
4. SHORTNAME: Abbreviation for measurement (e.g., SH, HT, etc.) in Microsoft Visual Basic program
5. ISCALIB: Switch in Microsoft Visual Basic program to indicate if measurement is calibrated
6. AXISSETTING: Selectable by operator (see Dimension Defaults box in Fig. 9) to set measurement axis as vertical, horizontal, or floating (any angle between vertical and horizontal)
7. RESCALE: Multiplication factor to modify default calibration values for this specific measurement
8. MOVED: "1" or "-1" to indicate if the operator has moved the measurement bar
9. LENGTH: Number generated in Microsoft Visual Basic program
10. X1: x pixel location for one end of measurement bar
11. Y1: y pixel location for one end of measurement bar
12. X2: x pixel location for one end of measurement bar
13. Y2: y pixel location for one end of measurement bar
14. CAP1X: x pixel location for measurement short name caption
15. CAP1Y: y pixel location for measurement short name caption
16. CAP2X: x pixel location for measurement value caption
17. CAP2Y: y pixel location for measurement value caption

D. CHANGES DATABASE (changes:table in central.mdb)

This table is used to track any measurement change made to a DAVID file. Each time a change is made to a file (measurement changed, file deleted, etc.), an entry is made to this table.

1. SSN: Entry typed in by operator in demographic data field of Remote Program
2. ENTRYDATE: Entry typed in by operator in demographic data field of Remote Program
3. TABLE: Which one of the central.mdb tables changed
5. FIELD: Description of action taken (dimension, delete file, etc.)
6. CHANGEDATE: Last date file was changed
7. OLDVALUE: Previous value for measurement
8. NEWVALUE: Value measurement changed to
9. OPER: Initials of operator making changes

E. CURRENT UNSAVED DIMENSIONS DATABASE (dimen_cur:table of central.MBD)

This database contains the information for the active file if the **Save** button has not been pressed.

1. SSN: Entry typed in by operator in demographic data field of Remote Program
2. ENTRYDATE: Entry typed in by operator in demographic data field of Remote Program
3. IMAGENAME: Name used in Visual Basic program to identify camera image
4. DIMENSIONNAME: Name of dimension in Microsoft Visual Basic program
5. SHORTNAME: Abbreviation for measurement (e.g., SH, HT, etc.) in Microsoft Visual Basic program
6. ISCALIB: Switch in Microsoft Visual Basic program to indicate if measurement is calibrated
7. AXISSETTING: Selectable by operator (see Dimension Defaults box in Fig. 9) to set measurement axis as vertical, horizontal, or floating (any angle between vertical and horizontal)
8. RESCALE: Multiplication factor to modify default calibration values for this specific measurement
9. MOVED: "1" or "-1" to indicate if the operator has attempted to make a measurement by moving the ends of the measurement bar. This field is used by the program to change the color of the bar from red to green.
10. LENGTH: Calculated length of measurement
11. X1: x pixel location for one end of measurement bar
12. Y1: y pixel location for one end of measurement bar
13. X2: x pixel location for one end of measurement bar
14. Y2: y pixel location for one end of measurement bar
15. CAP1X: x pixel location for measurement short name caption
16. CAP1Y: y pixel location for measurement short name caption
17. CAP2X: x pixel location for measurement value caption
18. CAP2Y: y pixel location for measurement value caption

F. IMAGES DATABASE (images:tabe in central .mdb)

This database was established to show necessary information when the DAVID used up to four cameras. It is not important in the current one-camera version.

1. SSN: Entry typed in by operator in demographic data field of Remote Program
2. ENTRYDATE: Entry typed in by operator in demographic data field of Remote Program
3. IMAGENAME: Name used in Visual Basic program to identify camera image
4. CAMERA: Number of the camera (one-four) used for image
5. CALIBFACTOR: Not currently used
6. PICNAME: Not used in this version

G. CALIBRATION DATABASE (calib:tabe of cental.mdb)

Database containing the results of system calibrations:

1. LOCATION: Each DAVID location (currently USNA, NOMI, and Quantico) has a location name entered when the **Configure** button is activated in the remote program initial screen (see Fig. 4). This field displays the location where the file was generated.
2. UPDATE: Last date file was changed
3. IMAGENAME: Name used in Visual Basic program to identify camera image
4. DIMENSIONNAME: Name of dimension in Microsoft Visual Basic program
5. SHORTNAME: Abbreviation for measurement (e.g., SH, HT, etc.) in Microsoft Visual Basic program
6. AXISSETTING: Selectable by operator in the central program (see Dimension Defaults box in Fig. 9) to set measurement axis as vertical, horizontal, or floating (any angle between vertical and horizontal)
7. LENGTH: Measurement value

H. DEFAULT DIMENSIONS DATABASE (dimen:table in central program.mdb)

Database with the information on the initial location, name, and orientation for each measurement:

1. IMAGENAME: Name used in Visual Basic program to identify camera image
2. DIMENSIONNAME: Name of dimension in Microsoft Visual Basic program
3. SHORTNAME: Abbreviation for measurement (e.g., SH, HT, etc.) in Microsoft Visual Basic program
4. ISCALIB: Switch in Microsoft Visual Basic program to indicate if measurement is calibrated
5. AXISSETTING: Selectable by operator in the central program (see Dimension Defaults box in Fig. 9) to set measurement axis as vertical, horizontal, or floating (any angle between vertical and horizontal)
6. RESCALE: Multiplication factor to modify default calibration values for this specific measurement
7. DEFAULTX1: x pixel location for one end of measurement bar
8. DEFAULTY1: y pixel location for one end of measurement bar
9. DEFAULTX2: x pixel location for one end of measurement bar
10. DEFAULTY2: y pixel location for one end of measurement bar
11. CAP1X: x pixel location for measurement short name caption
12. CAP1Y: y pixel location for measurement short name caption
13. CAP2X: x pixel location for measurement value caption
14. CAP2Y: y pixel location for measurement value caption

I. IMAGE NAME DATABASE (imagename:table in central.mdb)

This database is not important in the current one-camera version.

1. IMAGENAME: Name used in Visual Basic program to identify camera image
2. CAMERA: Camera number (one-four) used for image

VII. TROUBLESHOOTING

A. COMPUTER PROBLEM

Computer will not boot up.

1. Check power connections.
2. Check monitor connections.

B. DAVID PROGRAM WILL NOT START

1. Locate application under "C:Program files\ DAVID\" and try to starting program manually by running "remote.exe."

2. Reload DAVID software (**WARNING**, data files must be archived on CD prior to reload or they will be lost when software is reinstalled**).**
   a. Establish a new "olddavidsoftware" folder in the DAVID folder and copy the entire contents of the DAVID directory into the new folder to temporarily back up the existing software/data.
   b. Delete all but the "old DAVID software" folder from the DAVID directory.
   c. Copy the entire contents of the back up DAVID software ZIP disk into the DAVID directory.
   d. Check the operation of the reloaded DAVID software by performing a calibration (check to make sure the "x" and "y" dimensions are correct in the dimension name box in the calibration database of the Central Program, see Chapter IV C 2).
   e. Once a calibration is performed, the system is ready to use.
   f. Copy "central.mdb" from the "olddavidsoftware" backup folder into the new central folder so the subject files will not be lost.

C. IMAGE-ACQUISITION PROBLEMS

If the DAVID program works properly but an image cannot be acquired in the Remote Program, check the operation of the camera and Flashpoint board.

1. Check to make sure there is power to the camera power supply and there is a good camera connection
2. Check the camera's BNC connector on the cable to the computer.
3. Close Remote Program and open the Flashpoint software from the desktop.

   a. If an image does not appear, use the drop-down menu to toggle between "LIVE" and "GRAB." If no image appears, the problem is either with the camera, power supply, Flashpoint board, or cable connecting the camera to the Flashpoint board. Each component should be replaced individually until the problem is corrected.

   b. If the image can be seen only when using Flashpoint (not through the DAVID software), then the problem is in the DAVID software, which and it must be reloaded as described above.

D. RUN-TIME ERROR PROBLEMS

RUN-TIME ERROR occurs in Central Program when a duplicate SSN is found. If a file is exported from the Remote Program that contains the same SSN as one in the database of the Central Program, this error will occur, and the program will lock up.

1. In Windows Explorer, go to "C:Program Files\DAVID\Central\" and choose "central.mdb." In that database, choose the "subj" table. Look for the two subjects that have duplicate SSNs and delete the one that you don't want or change one SSN to something different from other entries.

2. Restart the Central Program and complete the measurements on the new file.

E. PRINTER PROBLEMS

If a report cannot be printed using the DAVID software:

1. Check the operation of the printer using a different program, (e.g., Word, Excel, etc.) or print a test page using the printer diagnostic function.

2. If the printer is functioning in programs other than the DAVID, reload DAVID software as described above.

3. If the printer does not function with other programs, follow procedures for troubleshooting the printer.

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APPENDIX

FREQUENTLY OCCURING MEASUREMENT ERRORS

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FREQUENTLY OCCURING MEASUREMENT ERRORS

A. SITTING HEIGHT

1. **Incorrect Measurement**: This is an error in placement of the measurement bar at the head plate or the bottom of the measurement bar is not properly placed.
2. **Slouching**: The subject is not sitting up straight and appears to be slouching.
3. **Leaning Back**: The subject appears to be leaning back and not sitting up straight.
4. **Head Up**: The subject's head was not in the Frankfort Plane (defined as when a line passing through the right tragion (approximate ear hole) and the lowest point of the right orbit (eye socket is parallel with the floor) due to an upward tilt of the head.
5. **Head Down**: The subject's head is not in the Frankfort plane due to their head being tilted downward.

B. THUMB-TIP -REACH

1. **Incorrect Measurement.** The operator did not place one or both ends of the measurement bar at the correct landmark. Frequently this error occurs when the subject was either twisted slightly away from the camera or had stretched their arm forward and the operator did not identify the right shoulder blade correctly. If the subject is twisted, the operator may incorrectly choose the left shoulder blade or some other area of the left side of the back that protrudes behind the actual location of the right shoulder blade. When the subject stretches their arm forward, the shoulder blade rotates forward and is no longer the farthest point on the back (see Fig. A-1). With either the subject twisted or with arm stretched, incorrect landmark identification could result in a measurement significantly longer than if the correct landmark was used.

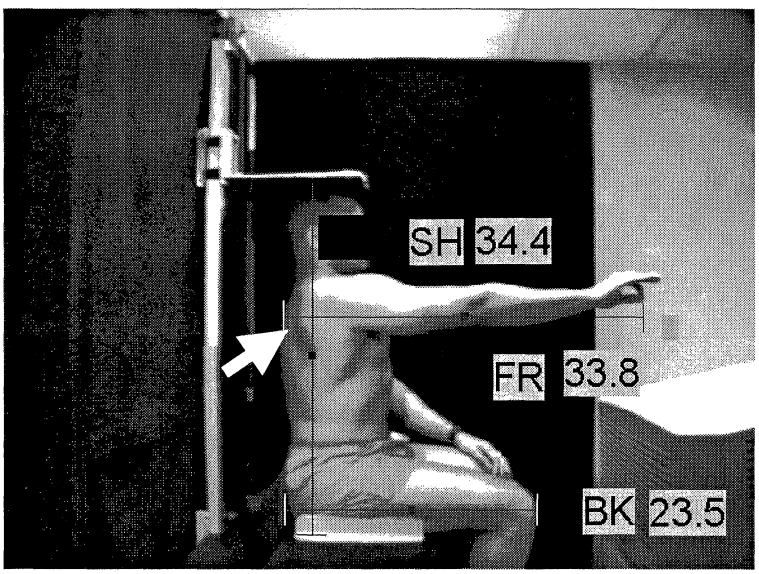

Figure A-1. The back landmark for thumb-tip reach is not on the shoulder blade. The white arrow shows the proper location for the landmark. Additionally, the subject's knee is slightly low resulting in his thigh not being parallel to the floor (see par. 3.c.).

2. **Thumb Orientation (General).** These errors are due to the subject's thumb extending behind or in front of the plane of their hand (see Fig. A-2).

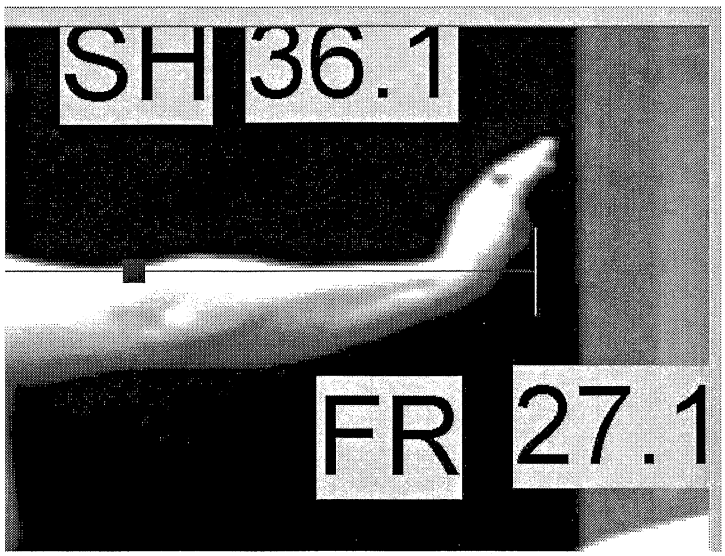

Figure A-2. Thumb should be in the axis of the extended arm.

3. **Thumb Down.** One of the most frequent errors is allowing the subject's thumb to angle down (see Fig. A-3). The thumb should be extended straight out in line with the axis of the extended arm.

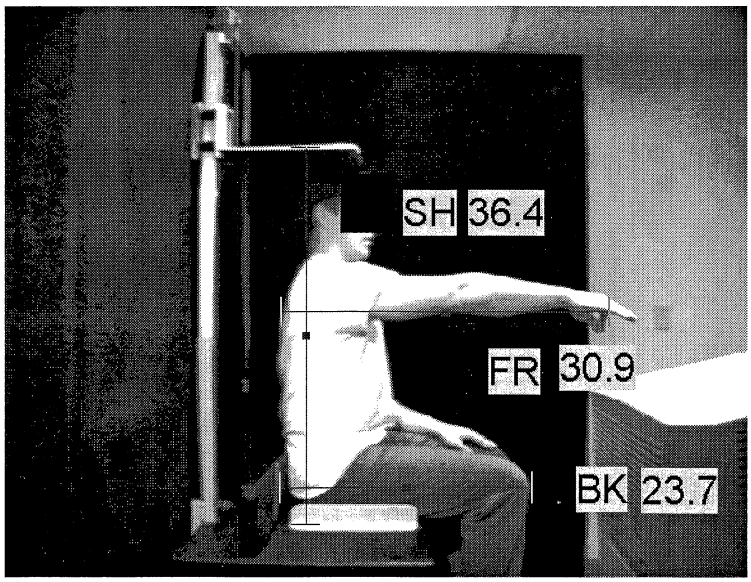

Figure A-3. The subject's thumb is pointed down, the thumb-tip landmark is difficult to find due to his shirt covering his back, and the buttock/knee length landmark identification is difficult without his pants leg raised above his knee.

4. **Thumb Up.** The subject's thumb is positioned at an upward angle and not in the axis of the extended arm (see Fig. A-4).

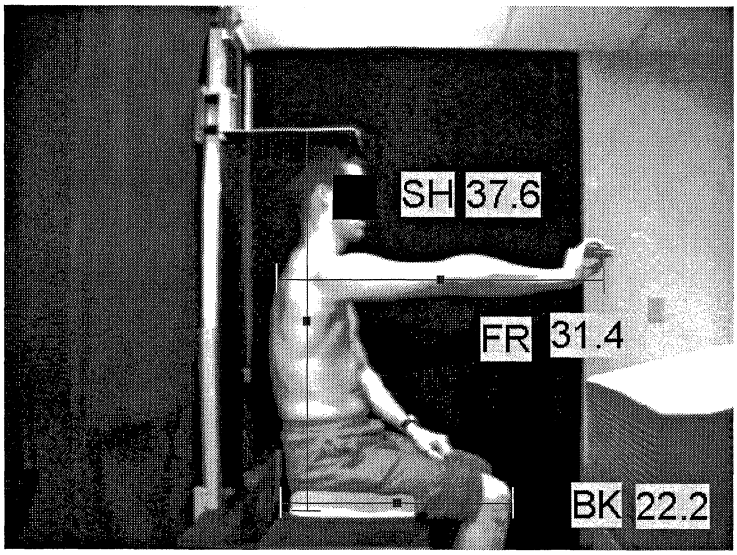

Figure A-4. The subject's thumb is angled up (not following the axis of the arm) and his knee is too low, resulting in the thigh not parallel with the floor.

5. **Thumb Bent.** This is another of the most frequently occurring errors. The thumb must be extended straight out in the axis of the extended arm. Figure A-5 shows a subject that has been allowed to bend their thumb (identifying if the thumb is bent is much easier on the computer image than in the printed image).

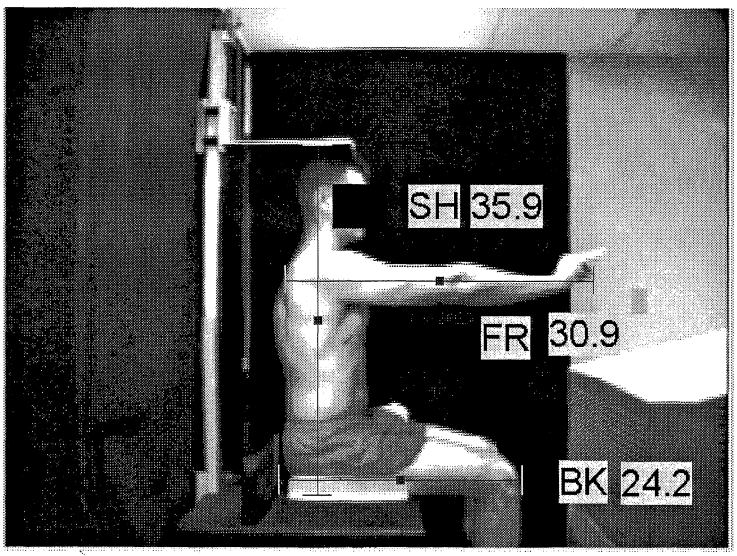

Figure A-5. The subject's thumb is bent and his knee is too low resulting in his thigh not being parallel with the floor.

6. **No Light.** The operator did not turn on the auxiliary DAVID light, resulting in a dark image and difficulty identifying the proper back landmark for the thumb-tip reach measurement (see Fig. A-6).

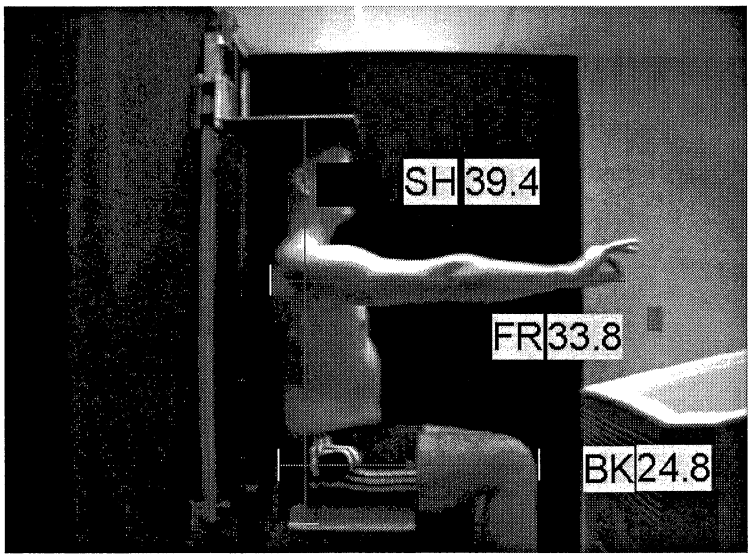

Figure A-6. The DAVID light is not on, resulting in difficult landmark identification. The buttock/knee length is slightly long.

7. **Wearing a Shirt.** A subject wearing a shirt can make it difficult to find the back landmark for thumb-tip reach (see Fig. A-3). If the shirt is pulled tight around their back and they are turned slightly toward the camera (so the left shoulder blade is not protruding further back than the right one), the landmark can be identified even if the subject is wearing a thin shirt such as a t-shirt.

C. BUTTOCK/KNEE LENGTH MEASUREMENT ERRORS

1. **Incorrect Measurement.** This error occurs when the operator incorrectly places the cursor at the knee landmark (see Fig. A-7).

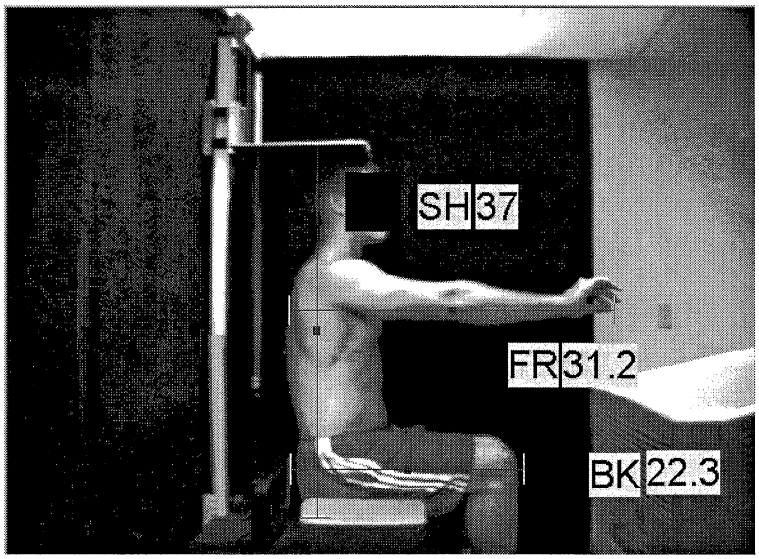

Figure A-7. The placement of the cursor for buttock/knee length is incorrect.

2. **Knee Raised Too High.** The subject's knee is held higher that that required to make their thigh parallel with the floor (see Fig. A-8).

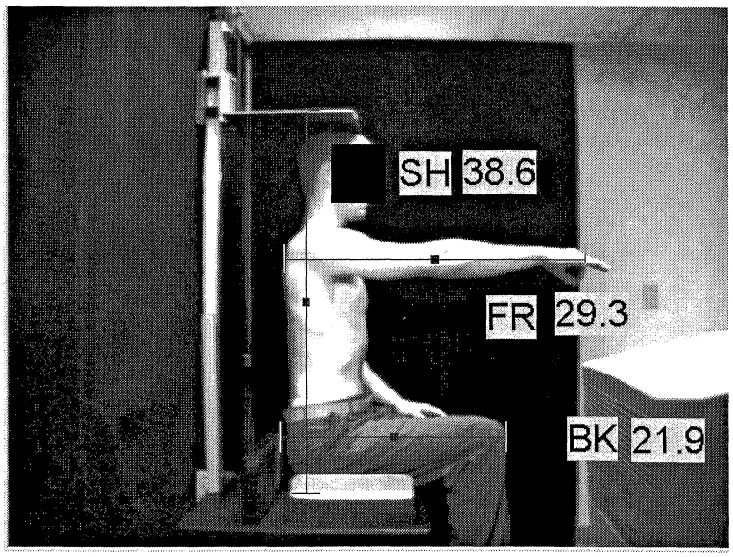

Figure A-8. The subject's thumb is angled down, his knee is too high (thigh is not parallel with the floor), and the right leg of his pants is not raised above his knee so the buttock/knee-length landmark identification is difficult.

3. **Knee Too Low.** The subject's knee is not raised high enough to make the thigh parallel with the floor (see Figs. A-1 & A-4).

4. **Wearing Pants (cannot see knee).** If the subject is wearing long pants, the right pants leg must be raised to expose the knee to determine if the thigh is parallel with the floor and to aid in identifying the knee landmark for thumb-tip reach (see Fig. A-8).

5. **Not Sitting Back Against the Backstop.** The subject must be sitting so they are against the backstop to obtain a correct buttock/knee length measurement. An easy way to identify if the subject is against the backstop is to see if the back of their pants is pressed against the backstop. Additionally, the subject's back should be behind the back edge of the metal bar attached to the sitting surface. Because the subject's right side should be against the metal bar, and there is a gap between the back of the metal bar and the backstop, a check to make sure the subject is behind the back edge of the metal bar is an easy way to evaluate if they are against the backstop. Figure A-9 shows a subject not against the backstop. Look at the position of the subject in Fig. A-9 and compare it with the other figures to see the difference when they are properly positioned.

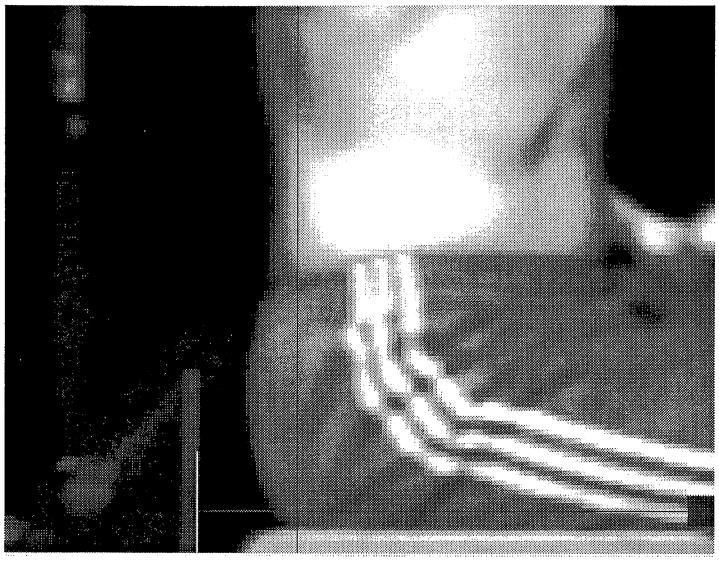

Figure A-9. The subject is not positioned against the backstop.

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13. ABSTRACT *(Maximum 200 words)*

The digital anthropometric video-imaging device (DAVID) was developed as a computer-based technology capable of accurately and reproducibly completing anthropometric measurements during medical screening of aviation candidates. The DAVID technology is currently employed as the anthropometric screening tool for naval aviation candidates, however, it is still undergoing modifications and revisions. This report is the first version of the operation manual. This report is written as a tool for DAVID operators to use to complete anthropometric measurements. It provides step-by-step procedures for entering demographic data, acquiring images, completing measurements, transferring/storing files, and calibrating the system.

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